Keywords: control loop, LDMOS, FET, bias, base station, power amplifier, RF

APPLICATION NOTE 4065

Implementing a MAX1385-Based Control Loop in C/C++

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Abstract: Maxim's MAX1385 evaluation kit (EV kit) software includes a Windows® graphical user interface (GUI) program; however, the time cost of updating this display interferes with the control loop. This application note shows a more optimal control-loop program, using a console menu system instead of a GUI.

When used with the MAX1385EVKIT+ demo board, the control loop achieves a regulation accuracy of ±2%. This accuracy is limited by the gate driver output step size and the FET transconductance. Drain-current regulation step size is determined by the MAX1385's gate-voltage increment multiplied by the FET's effective transconductance. Because the MAX1385EVKIT uses an IRFZ44N MOSFET to close the loop for demonstration purposes, the regulation may not be the same as it would be when used with an LDMOS FET.

Required Hardware

- Maxim MAX1385EVKIT+
- Maxim CMAXQUSB+ (includes USB A-B cable)
- Windows 2000/XP PC with USB port
- 5VDC at 100mA power supply
- 10VDC at 1000mA power supply
- DMM for measuring drain current
- DMM for measuring drain voltage
- DMM for measuring PGAOUT amplified current-sense voltage
- Optional: oscilloscope for monitoring GATE1 voltage and PGAOUT1 drain current

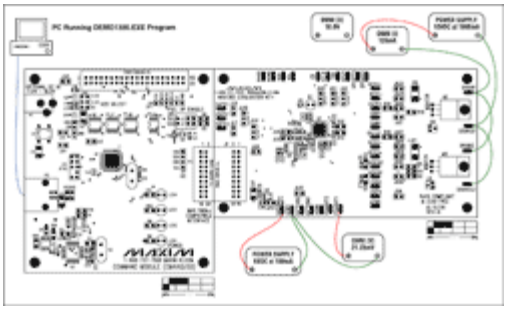
Setup

Download and unzip the necessary executable and source code files (ZIP, 736kB).

Assemble the hardware according to **Figure 1**.

- Plug the CMAXQUSB header P3 into the MAX1385EVKIT connector J1.
- Connect the MAX1385EVKIT's DRAIN1 and DRAIN2 pins to the current meter (-).
- Connect the current meter (+) to the power supply (+).
- Connect the MAX1385EVKIT's SOURCE1 and SOURCE2 pins to the power supply (-).
- Connect the voltage meter (+) to the MAX1385EVKIT's DRAIN1 pin.
- Connect the voltage meter (-) to the MAX1385EVKIT's SOURCE1 pin.

- Connect the MAX1385EVKIT's AVDD pin to the DVDD pin (or, optionally, connect to an external 5V DC supply).



More Detailed Image (PDF, 387kB)
Figure 1. MAX1385EVKIT hardware configuration.

Procedure

Set the CMAXQUSB's **VDD Select** jumper to the 5V position.

Connect the CMAXQUSB to the PC's USB port. If this is the first time a CMAXQUSB has been attached to the PC, the plug-and-play wizard will appear. Guide the GUI to the installed location of the device driver, in **MAX1385_Appnote_src.zip\src\USB_driver**.

Start the DEMO1385.EXE program. A console will appear on the screen. Enter the following series of commands at the console:

Command	Action

C	Connects to the CMAXQUSB module. Verify that the software reports: Board connected.
	
	`Got board banner: Maxim CMAXQUSB V01.04.32 >`
	
	`Searching for MAX1385...`
	`Found MAX1385 at 0x4e`
	
	`Note: when using MAX1385EVKIT with CMAXQUSB,`
	`connect 5V DVDD supply to AVDD.`

T V P	Test menu/verify power-up values
T S O FCT1 0300	Test menu/servo mode/output register/FineCalThru1 register, initial value 0x0300
T S I FF	Test menu/servo mode/input register/FIFO register
T S A 2	Test menu/servo mode/ADC command/trigger channel 2 (current CS1)
T S T 0020	Test menu/servo mode/target value 0x0020
T S C 1	Test menu/servo mode/convergence step positive 1
T S H 1	Test menu/servo mode/hysteresis one step
T S M 60000	Test menu/servo mode/maximum loop duration set to 60 seconds
T S R	Test menu/servo mode/run
T W FCT1 0300	Test menu/write register/FineCalThru1 register, value 0x0300

Monitor the regulation by watching the DMM.

The voltage on PGAOUT1 regulates between 20.8mV and 21.7mV, which is a variation of 0.45mV (2%)

around an average of 21.25mV.

Source Code Walk-Through

The source code was developed with the free dev-cpp IDE, which uses the GNU gcc-3.4.2 C++ compiler.

Listing 1 shows a simplified version of the C++ code performed inside the regulation loop. Output statements and error handling have been removed for clarity.

Listing 1. Simplified C++ code.

```
// read InputRegAddr8 into DeviceDataBuf16
if (InputRegAddr8 == MAX1385::rd_FIFO) {
   myDevice.ReadWord_HiLo(InputRegAddr8, &DeviceDataBuf16);
   if ((DeviceDataBuf16 & MAX1385::FIFO_Tag_Mask) == MAX1385::FIFO_F) {
      // FIFO contains FLAG, not the channel we were looking for.
      if ((DeviceDataBuf16 & MAX1385::FLAG_ADCBUSY) == 0) {
         // trigger another conversion
         myDevice.WriteWord_HiLo(MAX1385::wr_ADCCON,
               (1 << ADCCONselectedBit_0_6));
      }
      continue; // this C++ statement means go back to the start of the loop
   }
   // FIFO contains some channel data. Assume it's the correct channel.
   DeviceDataBuf16 &= MAX1385::FIFO_Data_Mask;
} else {
   // our input register is not the FIFO, so we just read the register directly
   myDevice.ReadWord_HiLo(InputRegAddr8, &DeviceDataBuf16);
}
// compare DeviceDataBuf16 to InputTargetData16, applying Hysteresis:  adjust OutputData16
if (DeviceDataBuf16 > InputTargetData16 + Hysteresis) {
   OutputData16 -= ConvergeStep;
}
else if (DeviceDataBuf16 < InputTargetData16 - Hysteresis) {
   OutputData16 += ConvergeStep;
}
// Write the output value
myDevice.WriteWord_HiLo(OutputRegAddr8, OutputData16);
```

Menu System

The complete source code implements the console menu system seen in **Listing 2**, which connects to the CMAXQUSB module.

Listing 2. Console menu system.

```
============================================================
CmodComm test program main menu when not connected
 A) adjust timing parameters
 L) CmodLog... functions
 C) connect
 D) Debug Messages
 X) exit

--------------------------------------------
```

```
C


Board connected.

Got board banner: Maxim CMAXQUSB V01.04.32 >

Searching for MAX1385...
Found MAX1385 at 0x4e

       Note: when using MAX1385EVKIT with CMAXQUSB,
             connect 5V DVDD supply to AVDD.


============================================================
CmodComm test program main menu after successful connect
 T) Test the device
 8) CmodP8Bus... functions
 A) adjust timing parameters
 L) CmodLog... functions
 P) CmodPin... functions
 S) CmodSpi... functions
 M) CmodSMBus... functions
 $) CmodCommStringWrite list of hex codes
 R) CmodBoardReset
 D) Disconnect


============================================================
T Test menu
T ?                     Hunt for active devices
T R                     Read register
T W                     Write register
T S                     Servo loop
T VP                    Verify Power-On Register Values
T VM reg mask           Verify Register Memory Persistence, All Combinations ...
T VW reg mask           Verify Register Memory Persistence, Walking-One's test ...

============================================================
Write register:
T W AD                  Write ADCCON
T W AH                  Write ALMHCFG
T W AS                  Write ALMSCFG
T W FI1                 Write FINE1
T W FI2                 Write FINE2
T W FC1                 Write FINECAL1
T W FC2                 Write FINECAL2
T W FCT1                Write FINECALTHRU1
T W FCT2                Write FINECALTHRU2
T W FT1                 Write FINETHRU1
T W FT2                 Write FINETHRU2
T W HC                  Write HCFG
T W HT1                 Write THRUHI1
T W HT2                 Write THRUHI2
T W HW1                 Write HIWIPE1
T W HW2                 Write HIWIPE2
T W IH1                 Write IH1
T W IH2                 Write IH2
T W IL1                 Write IL1
T W IL2                 Write IL2
T W LD                  Write LDAC
T W LT1                 Write THRULO1
T W LT2                 Write THRULO2
T W LW1                 Write LOWIPE1
T W LW2                 Write LOWIPE2
T W P                   Write PGACAL
T W SC                  Write SCLR
T W SS                  Write SSHUT
T W TH1                 Write TH1
```

```
T W TH2                 Write TH2
T W TL1                 Write TL1
T W TL2                 Write TL2
T W X /hexRegAddr/      Write any register by its hexadecimal address

============================================================
Read register:
T R AH                  Read ALMHCFG
T R AS                  Read ALMSCFG
T R FF                  Read FIFO
T R FI1                 Read FINE1
T R FI2                 Read FINE2
T R FL                  Read FLAG
T R HC                  Read HCFG
T R HW1                 Read HIWIPE1
T R HW2                 Read HIWIPE2
T R IH1                 Read IH1
T R IH2                 Read IH2
T R IL1                         Read IL1
T R IL2                         Read IL2
T R LW1                 Read LOWIPE1
T R LW2                 Read LOWIPE2
T R TH1                 Read TH1
T R TH2                 Read TH2
T R TL1                 Read TL1
T R TL2                 Read TL2
T R X /hexRegAddr/      Read any register by its hexadecimal address

============================================================
T S Test Servo menu
T S O FCT1 0300 output register [wr_FINECALTHRU1, initial value 0x0300]
T S I FF        input register [rd_FIFO]
T S A 2         ADC input channel [ bit 2 = 0x0004 = ADCCON_CURRENT_CS1 ]
T S T 0020      target value [0x0020]
T S C 1         ConvergeStep [1]
T S H 1         hysteresis [1]
T S M 60000     max_loop_duration_msec [60000]
T S R           servo loop run

============================================================
```


Related Parts		
MAX11008	Dual RF LDMOS Bias Controller with Nonvolatile Memory	Free Samples
MAX11014	Automatic RF MESFET Amplifier Drain-Current Controllers	Free Samples
MAX1385	Dual RF LDMOS Bias Controllers with I²C/SPI Interface	Free Samples
MAX1386	Dual RF LDMOS Bias Controllers with I²C/SPI Interface	

More Information
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